Exhibit B

14 Aug 2008, 4:05 pm - 4:35 pm

Soil and Structure Vibrations from Construction and Industrial Sources

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6th International Conference on
Case Histories in Geotechnical Engineering, Arlington, VA, August 11-16, 2008

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ABSTRACT

Construction and industrial dynamic sources can produce environmental vibration problems for adjacent and remote structures. High vibrations and unacceptable dynamic settlements could disturb sensitive devices and people and even be the cause of structural damage. The dynamic sources, the geology at a site, and the condition of structures affect ground and structure vibrations. Each construction or industrial site is unique and requires consideration of specific approaches at the site for decreasing vibration effects of construction activities or industrial dynamic sources on surrounding structures. Specifications prepared for a site, calculation and prediction of expected vibrations, and monitoring and control of ground and structural vibrations provide the rational to select measures for prevention or mitigation of vibration problems.

INTRODUCTION

Construction operations involve various sources of vibrations such as blasting, pile driving, dynamic compaction of weak soils, and others. Dynamic effects of these sources may create substantial vibration problems for surrounding buildings influencing structures, sensitive devices, and people. Neglecting vibration problems from construction activities can result in costly litigation and construction delays. Environmental vibration problems in construction of major building projects in urban areas are subjects for important consideration in obtaining the permit from appropriate authorities.

Industrial machines with impact loads, for example forge hammers, punch presses, and others are used for production processes at plants. Ignoring vibration effects of impact machine foundations can create problems for exterior walls of forge shops, people working in the offices at the plants, and residents in neighboring buildings.

The level of structural vibrations caused by construction and industrial sources depends mostly on dynamic loads transmitted on the ground, the medium of soil where wave propagate from the dynamic sources, soil conditions at a site, soil-structure interaction, and susceptibility of structures. Each factor can affect structural vibrations. Only dynamic sources can be modified in certain degree to comply with vibration limits. The rest of the factors cannot be changed. Construction and industrial vibrations differently affect adjacent and remote structures. Knowledge and experience in understanding the causes of vibration effects of construction and industrial sources can be helpful in prevention of harmful ground and structure vibrations.

Each construction or industrial site is different, and vibration mitigation measures should be correctly applied at a site. It is important to set performance criteria relating to vibrations and movement of surrounding buildings. Specifications for the control of construction vibrations should be prepared for major building projects. Harmful soil movements and structural damage from vibrations generated by construction and industrial sources can be prevented in most cases, Dowding (1996), Woods (1997), Svinkin (2004, 2005b).

SOURCES OF CONSTRUCTION AND INDUSTRIAL VIBRATIONS

Dynamic loads of construction sources are in the broad energy and frequency ranges. The maximum rated energy of the most commonly used impact hammers for construction on the land can be up to 300 kJ per blow. Only 30-50 % of this energy is usually transferred to driven piles. Frequencies of natural longitudinal pile oscillations change between 7 and 50 Hz. The maximum pile velocities and displacements measured at the head of steel, concrete and timber piles range from 0.9 to 4.6 m/s and between 12-35 mm, respectively. Vibratory drivers operate with different force amplitude in the frequency range of 10 to 30 Hz. The efficiency of sheet pile driving is below 30 % because of clutch friction between two sheet piles, Svinkin (1999).

For dynamic compaction of loose sands and granular fills, steel and concrete weights of 27 to 400 kN are usually